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FASCIATION IN OXALIS CRENATA AND EXPERIMENTAL
PRODUCTION OF FASCIATIONS.

BY HENRI HUS.

Oxalis crenata is largely grown in South America, more particularly in Peru, where it is known as "Oka," and in Bolivia where it flourishes on the Puna, a plateau 12,000 feet above sea level. It bears tubers (pl. 17, f. 1) three to four inches long and about an inch in diameter. They contain much starch and are used as food after having been exposed to the sun for two or three days and then boiled for about twenty minutes in water containing some cooking soda.

During four years more or less I had the opportunity to observe this plant in the experimental grounds at Berkeley, California, where it was grown from tubers received from the Botanic Garden at Sydney, N. S. W. Each year a number of fasciations of the stem made their appearance, but only in the latter part of the season. Some of the plants of the 1903 crop were chosen for purposes of illustration. Not only did they show the more normal type of fasciation, *i. e.*, a fasciated mainstem and branches, the majority of which are normal (pl. 18), but there also occurred instances where the entire plant was fasciated in the most fantastic manner and even bore tubers at various places on the aërial stem (pl. 19). Many of the tubers were likewise fasciated.

From Dr. Otto Kuntze it was learned that this fasciated condition is the one most frequently met with in Bolivia, and all plants of *Oxalis crenata* seen by him at Cochabamba were of this character. * There are no means of knowing

* Penzig in his *Pflanzen-Teratologie* mentions a fasciation of *Oxalis crenata* as enumerated by Crépin in *Recueil de faits tératologiques*, 2, (Bull. de la Soc. Roy. de Botanique de Belgique. 4: 276-278. 1865), but which was not found when the paper in question was referred to.

with exactitude what was the nature of the ancestors of our plants in the Sydney Botanical Garden, but for the present purpose the data gathered at Berkeley are sufficient.

The specimens of *Oxalis crenata* grown at Berkeley confirm in the most striking manner the views on the transmissibility of fasciations which at the present time are more generally held than formerly. Up to ten or fifteen years ago the consensus of opinion was that fasciation was an individual phenomenon and that its appearance depended entirely on external conditions. But a more careful study of the phenomena and especially the observations of de Vries * have shown that fasciation is a character which may be inherited, though to a varying degree. In some individuals it may seem to have disappeared, but only to reappear in their descendants. The latent condition of the character is also shown by trees which for some years produce fasciated branches and then normal ones, to be again followed by fasciated limbs. It has been shown by de Vries that in such cases the manifestation of fasciation is due to favorable external conditions. Unfavorable conditions have a tendency to prevent it. At Berkeley, plants of *Rhus diversiloba*, the poison oak, which had shown fasciation in the growth of three successive years, ceased to produce fasciations after being transplanted. Numerous similar instances might be quoted. As Goebel † points out and de Vries ‡ again recalls, wherever external influences cause the appearance of fasciations or anomalous structures in general the tendency to this must be present in a latent condition. If this tendency is absent all efforts to bring these structures about are futile.

That the fasciated character may remain dormant is well

* deVries, Hugo. *Die Mutationstheorie*. 2 : 541. Leipzig. 1901-1903.
— Here other references will be found.

† Goebel K. *Organographie der Pflanzen*. 1 : 158. Jena. 1898.

‡ *Loc. cit.* 551.

shown by our *Oxalis* tubers. Morphologically normal tubers, when planted, produced, in some cases at least, fasciated stems. Still another instance is yielded by the tuber illustrated in pl. 17, f. 2, which has the following history: — The plants, after having been photographed, were laid away on a shelf, tubers and all. Three months later, one of the tubers, slightly fasciated, was found to have sprouted and to have produced two stems, the one normal, the other fasciated. Artificial conditions, such as nutrition, irrigation, or the cutting away of parts were here entirely excluded. Yet the character is present, in the one case in an active, in the other, probably, in a latent condition.

Though it is well known that the members of some groups seem to have a greater tendency to fasciate than others, this tendency must occur very generally through the plant kingdom. Both Monocotyledons (*Asphodeline*, *Lilium*, *Asparagus* etc.) and Dicotyledons (*Verbascum*, *Acacia*, *Rosa*, *Sisymbrium* etc.), though the former to a lesser extent, yield numerous instances. But is this tendency present in all members of the plant world? De Vries* believes it not necessary to assume this. “Allerdings scheint die Anlage zu Verbänderungen im Pflanzenreich äusserst allgemein verbreitet zu sein, doch wohl nicht so allgemein, dass sie nicht gewissen Gruppen fehlen könnte.” Time and experiment will have to decide. Various methods are now known by which fasciation may be brought about. Heavy manuring may cause normal descendants of fasciated plants to fasciate (*Crepis biennis fasciata*).† The stems of biennials with a tendency to fasciation, if produced in the first year are mostly normal. But if they are produced during the second year, fine fasciated specimens are ordinarily the result (*Aster Tripolium*,

* *loc. cit.* 551.

† de Vries, H. *loc. cit.* 561.

Picris hieracioides etc.*) The time of sowing also seems to be of great influence. Goebel † calls attention to the fact that by leading the sap rapidly and with great intensity to a lateral bud, which ordinarily contains but little sap, fasciation may be produced. Thus he explains the frequent occurrence of fasciation in suckers and water-sprouts. Similarly, fasciation may be produced in annuals (*Phaseolus multiflorus*, *Vicia faba*) by cutting off the main stem directly above the cotyledons. Lopriore ‡ was able to produce root fasciation both by cutting off and by splitting the root tip, but did not succeed in producing it by subjecting roots to prolonged pressure. On the other hand, Sorauer § quotes an instance of a stem of *Tecoma radicans* which had become fasciated through appression to a wall, and of which the parts reaching above the wall likewise showed fasciation.

Experiments, mainly carried on at the Missouri Botanical Garden, have shown that at or just previous to the flowering period, plants, especially those with an indeterminate inflorescence, may be caused to fasciate by the use of the following method:—About the time of the appearance of the first flower the plant is kept as dry as possible, only enough water being given to prevent wilting. As a result the flowering period will be comparatively short, and, in an indeterminate inflorescence, the buds near the end of the spike remain undeveloped. If at this time the plants are daily abundantly irrigated, occasionally with manure-water, numerous fasciations will make their appearance. But it must be remembered that this result is usually reached only with plants which throughout their existence have

* *Ibid.* 549.

† Goebel, K. *loc. cit.* 164.

‡ Lopriore, G. I caratteri anatomici delle radici nastriformi. Rome. 1902.

§ Sorauer, P. Handbuch der Pflanzenkrankheiten. 1: 334. Berlin. 1906.

been well nourished and well cared for generally. For no apparent reason one plant will fasciate, while the next one, belonging to the same species, remains normal. This, however, affects in no way the value of the experiment, since this is undertaken only with a view to determining whether in any species fasciations can be produced. During 1905 fasciations were obtained by this method in *Antirrhinum majus*, *Actinomeris squarrosa*, *Solanum Lycopersicum* "Magnus," *Lythrum virgatum*, *Oenothera Lamarkiana* and *Collomia grandiflora*. Experiments with *Solanum Pseudo-capsicum*, *Capsicum annuum*, *Solanum nigrum* and *Abutilon Avicennae* yielded no fasciations.

It would seem that the cause of fasciation must be ascribed to the rapid introduction of sap into buds which would not normally produce them, as is suggested by Goebel. This is further borne out by observations on numerous plants, both cultivated and wild, growing at Berkeley, California. It was noted that within a week after a heavy rainfall at an unusual time (September, 1904), an abnormally large number of teratological cases were to be met with. They were not limited to fasciations, though these were most frequent, but included torsions, petalody of the stamens and phyllody of the pistil, frondiparous diaphysis — the prolongation of the axis through the center of the flower when the prolongation bears the character of a leafy shoot,* and fasciculations. One of the most interesting cases of the latter was met with in *Picris echinoides* which showed also a slight chlorosis of the flowers, which were stalked. Contrary to expectation, proliferation, *i. e.*, the production of secondary heads, which so often goes hand in hand with this phenomenon, was not observed.

* This may be frequently observed in the peloric variety of *Digitalis purpurea*.

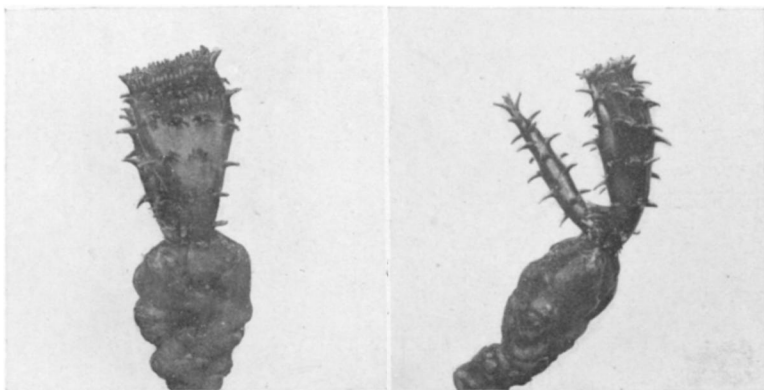
Among the most familiar instances of fasciation is that of the Asparagus. Interesting in this connection is the experience of an asparagus grower of California, who claims that the greater percentage of fasciated asparagus shoots is to be met with among those which are the first to pierce the soil, and especially so after a cold winter. This again would tend to confirm Goebel's view.

EXPLANATION OF PLATES.

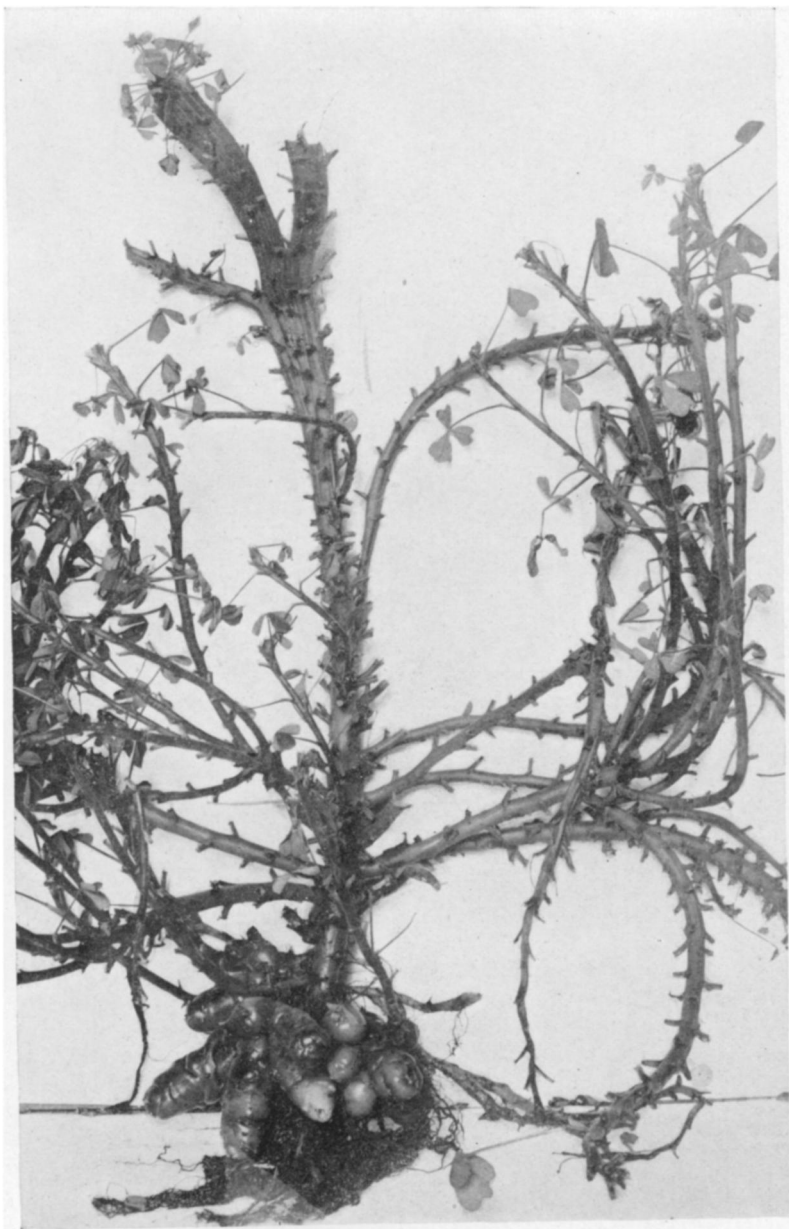
Plate 17. — *Oxalis crenata*. Above, normal tubers, $\times \frac{1}{2}$. Below, fasciated tuber bearing a normal and fasciated shoot; two views, slightly reduced.

Plate 18. — *Oxalis crenata*. A fasciated plant, $\times \frac{1}{6}$.

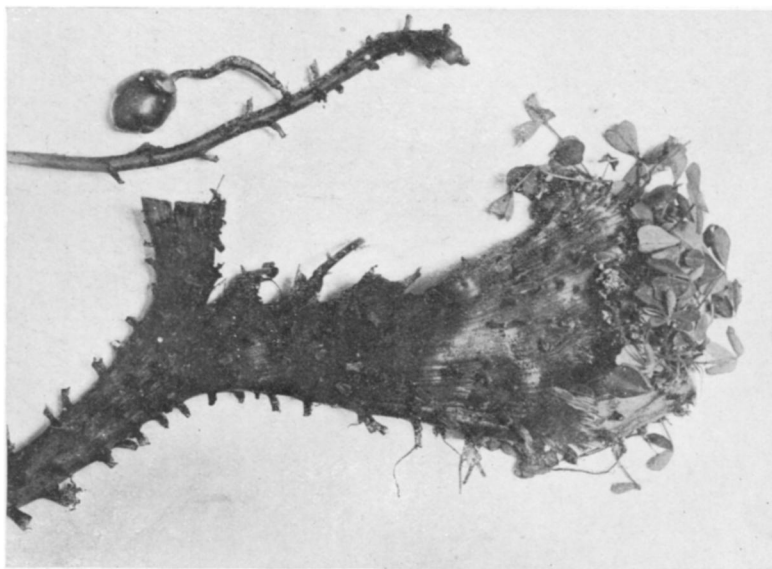
Plate 19. — *Oxalis crenata*. Three fasciated shoots, one of them, bearing a number of aerial tubers, $\times \frac{1}{4}$, the other two $\times \frac{1}{8}$.



OXALIS CRENATA.



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